Common European Financial Factors in Output-Gap Estimation: Evidence from 26 European Economies

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Abstract

The output gap is a central but unobservable concept in macroeconomic analysis. This paper examines whether common European and global financial factors improve country-level output-gap estimates for 26 European economies. Using a Borio-style state-space model, observed GDP is decomposed into latent potential output and a cyclical component. The cyclical equation is augmented with one common factor at a time, including the Eurostoxx50 return, financial stress, Brent oil price changes, exchange-rate changes, euro-area unemployment, short-term interest rate changes and a euro-area aggregate share price index.

The results show that the Eurostoxx50 return is the strongest common factor according to likelihood-based criteria. It improves the baseline model in almost all countries under the AIC and in most countries under the stricter BIC. Financial stress and oil prices also contain useful information, but their relevance is more selective and country-specific. However, the strong in-sample performance of the Eurostoxx50-augmented model does not uniformly translate into more credible output-gap estimates. Phillips-curve validation, real-time revision measures and visual inspection of potential-output paths give a more mixed picture.

The paper therefore reaches a cautious conclusion. Common European financial-market information is relevant for output-gap estimation, but likelihood-based improvements alone are not sufficient to establish economic reliability. The Eurostoxx50 return appears to be a powerful proxy for common financial-cycle conditions, but the Borio-style framework does not perform equally well across countries.

JEL codes: C32, E32, E44, E37

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1 Introduction

The output gap is a key concept in macroeconomic analysis, since it describes whether an economy is operating below or above its potential level of output. It is widely used in monetary policy, fiscal surveillance and the assessment of inflationary pressure. Since potential output is not directly observable, output-gap estimation necessarily requires a decomposition of observed GDP into a latent trend component and a cyclical component.

A long tradition of output-gap measurement relies on statistical decompositions of domestic output. Classical examples include the Hodrick–Prescott filter (Hodrick and Prescott, 1997) and the Beveridge–Nelson decomposition (Beveridge and Nelson, 1981). These approaches provide useful benchmarks, but they are limited by their reliance on the past behaviour of GDP itself. Orphanides and van Norden (2002) show that real-time output-gap estimates can be highly unreliable, especially because end-of-sample estimates of potential output are often revised substantially later. This is particularly problematic from a policy perspective, since the most recent estimates are also the most relevant for decision-making.

The limitations of univariate methods suggest that additional macroeconomic and financial information may be useful for identifying cyclical conditions. Macroeconomic relationships such as Okun's law (Ball et al., 2017) and Phillips-curve specifications using domestic and global output gaps (Jasova et al., 2018) show that output gaps are closely related to broader economic developments. However, recent research suggests that the most informative variables are not necessarily traditional macroeconomic indicators such as inflation, unemployment or interest rates, but financial and external variables. Borio et al. (2013) argue that potential output should be interpreted not only as non-inflationary output, but also as financially sustainable output. Financial imbalances can accumulate even when inflation remains stable, so output-gap estimates that ignore financial conditions may fail to detect unsustainable booms.

A related information-set perspective is developed by De Gorostiza-Roudnitski (2026), who studies which variables are most relevant for estimating output gaps in emerging economies. The paper finds that financial and external variables can be especially informative, particularly during major shocks. This motivates a broader question: if domestic output alone is insufficient, which additional variables should be included in the information set used to estimate national cyclical positions?

The European context is especially suitable for this question. EU economies are strongly connected through trade, production networks, financial markets and, for euro-area members, common monetary policy. As a result, national cyclical positions may partly reflect common European or global developments rather than purely domestic conditions. At the same time, European countries differ in openness, financial structure, energy exposure and institutional setting, so the same common factor may not be equally informative for all economies.

The literature on European output-gap co-movement supports this interpretation. Mink et al. (2012) show that output-gap coherence in the euro area cannot be captured adequately by simple correlations, because countries may differ in the sign, timing and amplitude of their cycles. More recently, de Haan et al. (2024) document that euro-area output-gap coherence did not increase monotonically and was affected by large common shocks. These findings suggest that European output gaps move together to some extent, but not mechanically or uniformly.

This paper therefore examines which common European and global factors contain useful information for country-level output-gap estimation. The analysis uses a Borio-style state-space framework for European countries and compares the incremental information content of several common factors, including stock market indicators, financial stress, oil prices, exchange rates, labour-market conditions and short-term interest rates. The central question is whether some common factors systematically help identify national cyclical positions, and whether their relevance differs across groups of European economies.

2 Methodology

2.1 Borio-style state-space framework

The empirical analysis is based on a parsimonious multivariate filter in the spirit of Borio et al. (2013). The purpose of the model is not to estimate a fully structural macroeconomic system, but to examine whether selected observable variables contain useful information for decomposing output into a latent trend and a cyclical component. This is especially relevant because potential output is unobserved, and the estimated output gap necessarily depends on the information set used in the filtering problem.

Let $y_{i,t}$ denote the logarithm of real GDP in country i, multiplied by 100. Output is decomposed into latent potential output, $y^*_{i,t}$, and the output gap, $g_{i,t}$:

$$y_{i,t} = y^*_{i,t} + g_{i,t}. \tag{1}$$

Potential output follows a smooth local trend:

$$y^*_{i,t} = 2y^*_{i,t-1} - y^*_{i,t-2} + \eta_{i,t}, \qquad \eta_{i,t} \sim N(0, \sigma^2_{\eta,i}). \tag{2}$$

This specification corresponds to the state-space representation of the Hodrick–Prescott filter. The disturbance $\eta_{i,t}$ governs changes in the growth rate of potential output: smaller values imply a smoother potential-output path, while larger values allow the trend to react more strongly to observed GDP movements.

2.2 Baseline and factor-augmented specifications

The baseline model assumes that the output gap follows a persistent autoregressive process:

$$g_{i,t} = \beta_i g_{i,t-1} + u_{i,t}, \qquad u_{i,t} \sim N(0, \sigma^2_{u,i}). \tag{3}$$

The parameter β_i captures the persistence of the cyclical component. Since an output gap is usually interpreted as a temporary deviation of actual output from potential output, very high values of β_i are economically important. In the empirical analysis, the estimated persistence of the cycle is therefore reported and used as a diagnostic indicator. Specifications in which the estimated output gap is close to a unit-root process are interpreted cautiously, even if they improve likelihood-based fit.

The factor-augmented specification adds one common European or global factor at a time:

$$g_{i,t} = \beta_i g_{i,t-1} + \gamma_{i,z} z_{t-k} + u_{i,t}, \qquad u_{i,t} \sim N(0, \sigma^2_{u,i}). \tag{4}$$

Here z_{t-k} denotes the common factor entering with lag k, and $\gamma_{i,z}$ measures the association between the factor and the cyclical component of output in country i. The conditioning variable affects the estimated decomposition only through the output-gap equation; it does not enter the potential-output equation directly. Accordingly, $\gamma_{i,z}$ is not interpreted as a structural causal effect. Instead, the coefficient is interpreted as evidence that the factor contains information that may help identify the cyclical position of the economy.

The one-factor-at-a-time design keeps the model deliberately parsimonious. This has two advantages. First, it makes the contribution of each candidate factor directly comparable with a corresponding univariate baseline. Second, it avoids estimating a large country-specific macro-financial system, which would be difficult to justify given the length of the quarterly samples and the number of countries considered.

2.3 Smoothing parameter and variance ratio

The decomposition of GDP into trend and cycle depends on the relative variance of the cycle and trend disturbances. In the standard quarterly HP filter, this trade-off is governed by the smoothing parameter $\lambda = 1600$. In the present state-space framework, the same idea is implemented by controlling the relative variability of the output gap and the second difference of potential output.

For a given country and model specification, the implied objective function can be written as

$$\sum_t \left(g_{i,t} - \beta_i g_{i,t-1} - \gamma_{i,z} z_{t-k}\right)^2 + \lambda_{i,z} \sum_t \left(\Delta^2 y^*_{i,t}\right)^2 . \tag{5}$$

In the baseline model, the term involving $\gamma_{i,z} z_{t-k}$ is omitted. The first part of the expression measures the unexplained component of the cyclical equation, while the second part penalises changes in the growth rate of potential output. A higher value of $\lambda_{i,z}$ produces a smoother potential-output estimate and assigns more short-run variation to the output gap.

Following Borio et al. (2013), I do not estimate the smoothing parameter freely as an unrestricted likelihood parameter. In short samples, this may lead to a pile-up problem: the estimated smoothing parameter can become too large, producing an excessively smooth potential-output path and an output gap that is too persistent. Instead, $\lambda_{i,z}$ is chosen in an outer iteration for each country and model specification.

The benchmark is the standard quarterly HP-filter decomposition computed on the same estimation sample. The value of $\lambda_{i,z}$ is selected so that the relative variability of the potential-output component in the state-space model is comparable to that implied by the HP benchmark. In practice, the model is re-estimated for alternative values of $\lambda_{i,z}$ until the Borio-style variance-ratio condition is approximately satisfied. This keeps the degree of trend smoothness broadly comparable across the baseline and factor-augmented specifications. As a result, differences between models are intended to reflect the incremental information content of the conditioning variable, rather than a mechanical change in the smoothness of the estimated potential-output path.

2.4 Estimation and same-sample comparison

For each country and each common factor, the state-space model is estimated by maximum likelihood using the Kalman filter. The factor-augmented model is always compared with a baseline model estimated on the same country-specific sample. This is important because the common factors have different availability and lag structures. Without a same-sample baseline, improvements in model fit could reflect differences in the estimation period rather than the information content of the factor.

The main model-comparison statistics are the changes in the Akaike and Bayesian information criteria:

$$\Delta AIC_{i,z} = AIC_{i,z}^{factor} - AIC_{i,z}^{baseline}, \tag{6}$$

and

$$\Delta BIC_{i,z} = BIC_{i,z}^{factor} - BIC_{i,z}^{baseline}. \tag{7}$$

Negative values indicate that the factor-augmented model improves upon the corresponding baseline. Since the BIC penalises additional parameters more strongly than the AIC, it is treated as the stricter criterion. I also report likelihood-ratio tests and the estimated factor coefficients. The empirical assessment is based on the joint evidence from these measures rather than on coefficient significance alone.

2.5 Interpretation and diagnostic checks

The methodology is designed to evaluate the incremental information content of common factors for output-gap estimation. A factor is considered empirically useful if it improves the likelihood-based fit of the state-space model relative to the same-sample baseline. However, better in-sample fit is not sufficient by itself to establish that the resulting output gap is economically credible.

For this reason, the empirical analysis also examines diagnostic features of the estimated models. Particular attention is paid to the persistence of the cyclical component, the shape of the estimated potential-output path and the robustness of the estimated gap in external validation exercises. This distinction is important because a factor may improve the statistical fit of the state-space system while still producing an output gap that is too persistent or a potential-output path that is difficult to interpret economically.

The results should therefore be read as evidence on information content rather than as structural estimates of the effect of financial variables on potential output or the business cycle. The common factors are used as filtering variables: they help determine how much of observed GDP variation is assigned to the cyclical component, but they are not treated as structural drivers of potential output.

3 Data

3.1 Country sample and domestic GDP

The analysis includes those European economies for which quarterly, seasonally and calendar adjusted real GDP is available from the Eurostat database from 1995Q1 onward. This selection leaves 26 countries in the sample: Austria, Belgium, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Latvia, Lithuania, Luxembourg, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and Türkiye.

The domestic output variable is quarterly real GDP, obtained from Eurostat quarterly national accounts. For each country i, the GDP series is transformed into logarithms as

$$y_{i,t} = 100 \log(Y_{i,t}), \tag{8}$$

where $Y_{i,t}$ denotes seasonally and calendar adjusted real GDP. The multiplication by 100 means that the estimated output gap can be interpreted approximately in percentage terms. The use of seasonally and calendar adjusted data is important because the state-space model is intended to separate trend and cyclical movements, not regular seasonal or calendar-driven fluctuations.

The country sample is not restricted to euro-area economies. It also includes non-euro EU countries and non-EU European comparison economies. This broader coverage is useful because the paper asks whether common European and global factors contain information for national output gaps beyond the euro area alone.

3.2 Common factors

The empirical exercise uses common European and global variables that may contain information about cyclical conditions across countries. The factors are taken from Eurostat, the ECB Data Portal, FRED and Yahoo Finance. Monthly and daily series are converted to quarterly frequency before entering the model. For a monthly or daily variable X_s, the quarterly mean is computed as

$$X_q = \frac{1}{n_q} \sum_{s \in q} X_s, \tag{9}$$

where n_q is the number of observations in quarter q. For financial market prices downloaded at daily frequency, the quarter-end value is used:

$$P_q = P_{\tau(q)}, \tag{10}$$

where $\tau(q)$ denotes the last available trading day of quarter q.

Variables expressed in levels and expected to be non-stationary are transformed into quarterly log changes:

$$\Delta \log X_t = 100 \left(\log X_t - \log X_{t-1} \right). \tag{11}$$

Interest rates enter as simple quarterly changes,

$$\Delta r_t = r_t - r_{t-1}. \tag{12}$$

Finally, after applying the selected lag and aligning the factor with the country-specific GDP sample, each conditioning variable is standardised on the actual estimation sample:

$$z_{i,t}^{std} = \frac{z_{t-k} - \bar{z}_i}{s_{z,i}}, \tag{13}$$

where $\bar{z}_i$ and $s_{z,i}$ are the sample mean and standard deviation of the aligned factor in the estimation sample for country i. This makes the scale of the conditioning variables comparable and avoids giving larger weights to variables simply because they are measured in larger units.

3.3 Financial market variables

The first financial variable is the EUR/USD exchange rate, downloaded from Yahoo Finance using the ticker `EURUSD=X`. The daily exchange rate is converted to a quarter-end series and then transformed into a quarterly log change. The series enters the model with two lags, so the effective estimation sample starts in 2004Q3. Exchange rate movements may be relevant for output-gap estimation because they capture external financial conditions, competitiveness effects and changes in the cost of imported inputs. This is especially important for small open economies, where external prices and financial-market sentiment can affect domestic cyclical conditions.

The second financial variable is the euro-area aggregate share price index, obtained from FRED using the series `SPASTT01EZQ661N`. It is transformed into a quarterly log return and enters the model with two lags. Because of this lag structure, the effective sample starts in 1995Q3. This variable captures broad euro-area equity-market conditions. Asset prices may contain forward-looking information about expected profits, discount rates and financial conditions, and therefore may help identify cyclical movements in output. This follows the logic of Borio et al. (2013), who argue that financial variables can contain information about the sustainability of output developments.

The third financial-market variable is the Eurostoxx50 index, downloaded from Yahoo Finance using the ticker `^STOXX50E`. The daily index is converted to a quarter-end series and transformed into a quarterly log return. In the available data used here, the transformed series starts in 2007Q2 and enters the model contemporaneously. While the euro-area share price index is an aggregate statistical indicator, the Eurostoxx50 is a market-based index of large European firms. It is therefore interpreted as a broad European stock-market cycle indicator.

3.4 Financial stress

Financial stress is measured by the ECB Composite Indicator of Systemic Stress (CISS), downloaded from the ECB Data Portal. The CISS aggregates stress in several segments of the financial system and is designed to measure systemic financial tensions (Holló et al., 2012). The daily CISS series is converted to a quarterly average and then standardised. The effective sample starts in 1995Q1.

The CISS is relevant for output-gap estimation because financial stress can tighten credit conditions, reduce risk-taking and amplify downturns. In the Borio-style interpretation, such financial variables may help distinguish between sustainable and unsustainable movements in output (Borio et al., 2013). Unlike stock-market returns, the CISS is not primarily a broad asset-price indicator; it is intended to capture periods of systemic stress in the financial system.

3.5 Oil prices

Oil prices are represented by the Brent crude oil price, obtained from FRED using the series `MCOILBRENTEU`. The monthly dollar price of Brent oil is first converted to a quarterly average and then transformed into a quarterly log change. The effective sample starts in 1995Q1.

Brent oil prices may be relevant because energy-price movements can affect production costs, household purchasing power, inflationary pressure and external balances. However, the interpretation of oil-price movements is not mechanical: the macroeconomic effect of oil prices depends on whether the movement is driven by supply shocks, global demand shocks or oil-specific demand. This motivates the use of oil prices as a possible common external factor, while also suggesting that its relevance may differ across countries (Baumeister and Hamilton, 2019).

3.6 Monetary and labour-market variables

The euro-area three-month interbank rate is obtained from FRED using the series `IR3TIB01EZQ156N`. It is transformed into a quarterly change and enters the model contemporaneously. The effective sample starts in 1995Q1. This variable captures common short-term monetary and financial conditions in the euro area. Interest-rate variables are also considered by Borio et al. (2013), although their results suggest that financial-cycle variables may contain more information about cyclical output than standard interest-rate measures.

The euro-area unemployment rate is obtained from FRED using the series `LRHUTTTTEZM156S`. The monthly unemployment rate is converted to a quarterly average and standardised. In the dataset used here, the effective sample runs from 1995Q1 to 2023Q1. Unemployment is a natural candidate variable because it is closely linked to cyclical slack through Okun's law (Ball et al., 2017). At the same time, it may react with a delay to changes in output, which is why the empirical analysis compares its information content with faster-moving financial variables.

3.7 Summary of transformations

Table 1 summarises the common factors, their sources, transformations and effective starting dates in the estimation sample. The lag structure was selected on the basis of preliminary specification tests: for each candidate variable, alternative lags were compared and the lag with the strongest empirical performance was retained. This follows the approach of Borio et al. (2013), who allow conditioning variables to enter with alternative lags and choose the specification that maximises their contribution to the estimated output gap.

Table 1: Common factors and transformations

Variable	Source	Transformation	Lag	Effective start
EUR/USD exchange rate	Yahoo Finance, `EURUSD=X`	Quarter-end value, $100\Delta\log$	2	2004Q3
Euro-area share price index	FRED, `SPASTT01EZQ661N`	Quarterly log return, $100\Delta\log$	2	1995Q3
Eurostoxx50 index	Yahoo Finance, `^STOXX50E`	Quarter-end value, $100\Delta\log$	0	2007Q2
ECB CISS	ECB Data Portal	Quarterly mean, standardised	0	1995Q1
Brent oil price	FRED, `MCOILBRENTEU`	Quarterly mean, $100\Delta\log$	0	1995Q1
Euro-area 3-month interbank rate	FRED, `IR3TIB01EZQ156N`	Quarterly change	0	1995Q1
Euro-area unemployment rate	FRED, `LRHUTTTTEZM156S`	Quarterly mean, standardised	0	1995Q1–2023Q1

Note: The reported lags were selected after preliminary lag-comparison tests. Following the specification strategy of Borio et al. (2013), the conditioning variables were allowed to enter with alternative lags, and the lag with the strongest contribution to the output-gap equation was retained.

4 Empirical Results

This section evaluates the empirical performance of the common factors in the country-level output-gap models. I first compare the variables individually using changes in AIC and BIC, likelihood-ratio tests, and the estimated factor coefficients. I then focus on the three most relevant factors—the Eurostoxx50 return, the CISS financial stress indicator and Brent oil price changes—and examine whether their importance differs systematically across European country groups. The results are interpreted as evidence on the information content of common factors, not as causal effects.

Table 2: Summary of common factor performance across countries

Common factor	$\Delta BIC < 0$	$\Delta AIC < 0$	$p < 0.01$	$p < 0.05$	$p < 0.10$
Eurostoxx50 return	23/26	24/26	21/26	24/26	24/26
CISS financial stress	8/26	15/26	5/26	11/26	13/26
Brent oil price change	4/26	11/26	2/26	5/26	8/26
Euro-area share price index	3/26	11/26	0/26	4/26	5/26
Euro-area 3-month rate change	2/26	8/26	0/26	4/26	6/26
Euro-area unemployment rate	1/26	9/26	1/26	3/26	5/26
EUR/USD exchange-rate change	1/26	4/26	0/26	1/26	1/26

Note: The table reports the number of countries, out of 26, for which the factor-augmented model improves upon the corresponding same-sample baseline model. AIC and BIC improvements are defined as $\Delta AIC < 0$ and $\Delta BIC < 0$, respectively. The significance columns refer to the likelihood-ratio test comparing the factor-augmented model to the baseline model.

Table 2 shows a clear ranking of the common factors. The Eurostoxx50 return is by far the most robust variable. It improves the univariate baseline model in 24 out of 26 countries according to the AIC and in 23 countries according to the stricter BIC criterion. The likelihood-ratio test also supports this result: the Eurostoxx50-augmented model is significant at the 5 percent level in 24 countries and at the 1 percent level in 21 countries. This suggests that broad European stock-market conditions contain systematic information about national cyclical positions.

The second most relevant variable is the CISS financial stress indicator, but its performance is much more heterogeneous. It improves the AIC in 15 countries, but the BIC only in 8 countries, indicating that its contribution is less universal once the stronger penalty for additional parameters is taken into account. The likelihood-ratio test is significant at the 5 percent level in 11 countries and at the 10 percent level in 13 countries. This pattern suggests that financial stress is informative for a subset of countries, but it is not a general common factor in the same way as the Eurostoxx50 return.

Brent oil price changes have a weaker and more selective role. The AIC improves in 11 countries, but the BIC improves in only 4 countries, and the likelihood-ratio test is significant at the 5 percent level in only 5 countries. This indicates that the oil-price channel may matter for some economies, but its information content is clearly more country-specific. The remaining variables perform worse. The euro-area aggregate share price index, the euro-area three-month rate, euro-area unemployment and the EUR/USD exchange rate improve the model only in a limited number of countries, especially under the BIC criterion.

Overall, the results suggest that financial-market variables are more informative than slower-moving macroeconomic variables in this framework. However, not all financial variables perform equally well. The Eurostoxx50 return stands out as a broad European financial-cycle indicator, while the CISS and Brent oil price changes provide additional information only for more limited groups of countries.

Table 3: Country-level results for Eurostoxx50, Brent oil price and CISS

	Eurostoxx50			Brent oil price			CISS		
Country	β	γ	ΔAIC	β	γ	ΔAIC	β	γ	ΔAIC
Belgium	0.652	0.737	-6.515	0.671	0.103	1.973	0.679	-0.142	1.536
Czechia	1.019	0.701	-8.663	0.929	0.184	-0.164	0.940	-0.328	-1.129
Denmark	0.778	0.432	-2.487	0.776	0.235	-1.430	0.752	-0.349	-3.668
Germany	0.872	0.737	-8.299	0.770	0.257	-2.005	0.770	-0.311	-1.934
Estonia	1.019	0.748	-8.146	0.995	0.366	-2.887	0.924	-0.726	-10.739
Ireland	0.804	0.376	1.175	0.793	-0.310	0.122	0.838	-0.541	-1.244
Greece	1.013	1.129	-14.216	0.914	0.228	0.334	0.971	-0.279	1.004
Spain	0.814	1.120	-6.301	0.742	0.095	1.877	0.752	-0.159	1.527
France	0.641	0.853	-5.655	0.668	0.050	1.696	0.662	-0.191	1.427
Croatia	1.010	1.025	-7.800	0.828	0.372	-1.276	0.817	-0.563	-2.670
Latvia	1.025	1.117	-13.291	0.976	0.122	1.609	0.951	-0.749	-6.239
Lithuania	1.015	0.841	-10.272	1.009	0.411	-4.965	0.927	-0.931	-15.677
Luxembourg	0.669	0.888	-14.995	0.776	0.061	1.121	0.803	-0.186	1.006
Hungary	0.777	0.851	-4.972	0.685	0.296	-0.413	0.662	-0.524	-4.572
Austria	0.747	0.711	-3.934	0.758	0.127	1.522	0.768	-0.150	0.762
Poland	1.020	0.660	-10.321	0.834	0.109	1.656	1.011	-0.281	-0.517
Portugal	0.766	0.991	-6.717	0.758	0.069	1.981	0.766	-0.093	1.725
Romania	1.020	1.243	-12.249	0.740	0.667	-5.477	0.735	-0.434	-0.323
Slovakia	0.793	0.684	-7.838	0.866	0.279	-0.529	0.810	-0.586	-4.800
Finland	1.023	0.741	-11.754	1.001	0.257	-2.813	0.993	-0.430	-4.800
Sweden	0.951	0.814	-11.358	0.819	0.049	1.487	0.798	-0.365	-3.663
Iceland	0.761	0.386	0.983	0.792	0.327	0.496	0.812	-0.584	-0.637
Norway	0.737	0.314	-1.869	0.815	0.042	1.906	0.855	-0.170	0.202
Switzerland	0.814	0.419	-7.046	0.843	0.160	-0.791	0.861	-0.152	0.018
Serbia	0.822	0.691	-5.633	0.636	0.196	1.628	0.622	-0.343	1.180
Türkiye	0.786	1.149	-11.276	0.902	0.142	1.666	0.792	-0.765	-2.602

Note: ΔAIC is defined as the AIC of the factor-augmented model minus the AIC of the corresponding same-sample baseline model. Negative values therefore indicate an improvement relative to the baseline. The reported β and γ values are taken directly from the one-factor state-space estimations.

A further qualification concerns the estimated persistence of the cyclical component. In several cases the estimated β coefficient exceeds 0.95. Such values imply that the output gap is close to a unit-root process. This is difficult to reconcile with the usual interpretation of the output gap as a temporary business-cycle component, since the estimated cycle becomes almost permanent. I therefore interpret these cases cautiously: they indicate that the model did not succeed in isolating a clearly mean-reverting output gap.

Interestingly, this problem occurs most frequently in the Eurostoxx50 specifications. While the Eurostoxx50 return strongly improves the likelihood and information criteria in most countries, the corresponding output-gap process is sometimes estimated to be excessively persistent. This suggests that the Eurostoxx50 contains substantial information about common cyclical movements, but that for some countries the factor-augmented model may attribute too much persistent variation to the cyclical component rather than to potential output.

The country-level results also reveal meaningful heterogeneity across groups of countries. The Eurostoxx50 return is the only factor whose contribution is not confined to a specific region. It improves the model in almost all countries, including core euro-area economies, Southern European countries, Central and Eastern European economies and non-euro European countries. This suggests that the Eurostoxx50 captures a broad common European financial cycle rather than a region-specific shock.

At the same time, the interpretation of the Eurostoxx50 results requires some caution. The cases with very high estimated β values are concentrated mainly among Central and Eastern European and Baltic economies, although they also appear in a few other countries. In these cases, the model improves the likelihood-based fit, but the estimated cyclical component becomes highly persistent. This suggests that the Eurostoxx50 contains relevant common information, but that in some economies the distinction between persistent trend movements and cyclical movements becomes less clear.

The CISS financial stress indicator displays a more regional pattern. Its strongest improvements are observed in the Baltic economies and in several Central and Eastern European countries, such as Estonia, Latvia, Lithuania, Hungary, Slovakia and Croatia, as well as in some small open economies such as Denmark, Finland and Sweden. This suggests that common financial stress is more informative for output-gap estimation in economies that are more exposed to external financial conditions. By contrast, the CISS does not systematically improve the model for the large Southern European economies in the sample.

Brent oil price changes are even more selective. The oil-price factor improves the model for a limited number of countries, including Romania, Lithuania, Estonia, Finland, Germany and Denmark, but it performs weakly for many others. This indicates that oil prices do not act as a general European cyclical indicator in this framework. Their information content appears to depend more on country-specific exposure to energy prices and external shocks.

Overall, the regional evidence strengthens the main conclusion. The Eurostoxx50 return is the most robust common factor because its information content is visible across almost all country groups. The CISS and Brent oil price changes, by contrast, provide useful information only for more specific subsets of countries. Therefore, the Eurostoxx50 can be interpreted as a broad European financial-cycle indicator, while the other variables capture more selective channels.

5 Validation of the results

The previous results suggest that the Eurostoxx50 return is the most robust common factor in the country-level models. Following the logic of Borio et al. (2013), I do not interpret this variable as a structural determinant of potential output. Instead, it is used as an observable financial indicator that may help identify the cyclical component of output. Since potential output is unobserved, the trend–cycle decomposition depends on the information set used in the filtering problem. If financial developments contain information about cyclical conditions, ignoring them may lead the model to assign part of cyclical variation to potential output.

The Eurostoxx50 return is especially suitable in the European setting, because it captures common same-quarter movements in equity valuations, risk appetite and financial conditions. It is therefore interpreted as a common European financial-cycle proxy rather than as a forecasting variable. This is close to Melolinna and Tóth (2016), who incorporate financial and asset-price indicators, including equity-market information, into an unobserved-components framework for estimating output gaps. Related evidence on the empirical link between output gaps and stock returns is provided by Vivian and Wohar (2013), although their focus is on whether output gaps help explain stock returns.

I complement the likelihood-based comparison with two external validation exercises. The first one is a Phillips-curve validation exercise. The motivation is that, under the traditional interpretation of the output gap, a more informative measure of cyclical slack should contain information about subsequent inflationary pressure. For each country, I estimate the following reduced-form inflation equation:

$$\pi_{i,t} = \alpha_i + \rho_i \pi_{i,t-1} + \theta_i \hat{g}_{i,t-1} + \varepsilon_{i,t}, \tag{14}$$

where $\pi_{i,t}$ denotes year-on-year HICP inflation and $\hat{g}_{i,t-1}$ is the one-quarter-lagged estimated output gap. Monthly all-items HICP indices from Eurostat are first converted to quarterly frequency by taking quarterly averages. Inflation is then computed as

$$\pi_{i,t} = 100 \left(\log HICP_{i,t} - \log HICP_{i,t-4} \right).$$

The regression is estimated separately for the baseline output gap and for the Eurostoxx50-augmented output gap, using the same country-specific matched sample. Standard errors are computed using HAC covariance estimates with four lags, reflecting the overlapping nature of year-on-year inflation.

The two Phillips-curve specifications are compared using AIC, BIC, RMSE, R^2, adjusted R^2, and the statistical significance of the output-gap coefficient θ_i. In the main summary table I focus on AIC and RMSE differences, because they provide a compact comparison of the predictive fit of the two gaps in the inflation equation. This exercise is interpreted only as a supplementary external validation check: the Eurostoxx50-augmented model is not designed to maximise the fit of an inflation equation, and following Borio et al. (2013), inflation is not assumed to be the only or necessarily the most informative symptom of cyclical unsustainability.

The second exercise follows the real-time evaluation logic of Borio et al. (2013). The model is first estimated on a shortened sample ending in 2024Q4, and then the endpoint is extended one quarter at a time. For each endpoint, I record the last available real-time output-gap estimate and compare it with the corresponding full-sample estimate:

$$r_{i,t} = \hat{g}_{i,t}^{RT} - \hat{g}_{i,t}^{full}. \tag{15}$$

A model is considered more stable in real time if the absolute revision, $|r_{i,t}|$, is smaller. I therefore compare the mean absolute revision of the baseline and Eurostoxx50-augmented models. Smaller revisions indicate that the estimated cyclical position is less sensitive to the arrival of new observations.

Table 4: Phillips-curve validation and real-time revision: baseline versus Eurostoxx50

	Phillips-curve validation		Real-time revision			Eurostoxx improves	
Country	ΔAIC^{PC}	$\Delta RMSE^{PC}$	MAR^{base}	MAR^{Euro}	ΔMAR	PC	RT
Belgium	-0.043	-0.0003	0.333	0.335	0.002	✓	–
Czechia	-0.164	-0.0015	0.335	0.054	-0.281	✓	✓
Denmark	0.124	0.0007	0.433	0.465	0.032	–	–
Germany	-0.097	-0.0005	0.063	0.113	0.050	✓	–
Estonia	5.682	0.0692	0.589	2.985	2.396	–	–
Ireland	0.072	0.0003	1.897	2.002	0.105	–	–
Greece	3.576	0.0246	0.337	0.102	-0.236	–	✓
Spain	0.125	0.0008	0.063	0.097	0.034	–	–
France	0.042	0.0002	0.100	0.102	0.001	–	–
Croatia	-0.212	-0.0015	0.093	0.207	0.114	✓	–
Latvia	4.696	0.0612	0.731	2.470	1.738	–	–
Lithuania	-0.091	-0.0010	0.396	0.214	-0.182	✓	✓
Luxembourg	0.303	0.0020	0.103	0.184	0.080	–	–
Hungary	0.033	0.0004	0.378	0.290	-0.088	–	✓
Austria	-0.010	-0.0000	0.174	0.162	-0.012	✓	✓
Poland	3.066	0.0205	0.124	0.404	0.280	–	–
Portugal	-0.052	-0.0003	0.113	0.123	0.010	✓	–
Romania	-0.628	-0.0050	1.052	0.366	-0.687	✓	✓
Slovakia	-0.182	-0.0013	0.330	0.288	-0.041	✓	✓
Finland	2.472	0.0116	0.070	0.474	0.404	–	–
Sweden	-0.834	-0.0040	0.184	0.151	-0.032	✓	✓
Iceland	0.101	0.0010	0.536	0.534	-0.002	–	✓
Norway	0.043	0.0002	0.108	0.155	0.048	–	–
Switzerland	-0.055	-0.0002	0.401	0.469	0.069	✓	–
Serbia	0.006	0.0001	0.217	0.181	-0.037	–	✓
Türkiye	-0.376	-0.0106	0.437	0.466	0.029	✓	–

Note: ΔAIC^{PC} and $\Delta RMSE^{PC}$ are defined as the Phillips-curve value obtained with the Eurostoxx50-augmented gap minus the value obtained with the baseline gap. Negative values therefore indicate that the Eurostoxx50 gap performs better in the Phillips-curve regression. MAR denotes the mean absolute real-time revision, computed as the average absolute difference between the recursive real-time gap estimate and the corresponding full-sample estimate. $\Delta MAR = MAR^{Euro} - MAR^{base}$, so negative values indicate smaller revisions for the Eurostoxx50-augmented model. A checkmark indicates an improvement according to $\Delta AIC^{PC} < 0$ for the Phillips-curve test and $\Delta MAR < 0$ for the real-time revision test.

Before drawing conclusions from these validation exercises, it is useful to look directly at the estimated GDP and potential-output paths. Figure 1 compares actual GDP, the baseline potential-output estimate and the Eurostoxx50-augmented potential-output estimate for each country.

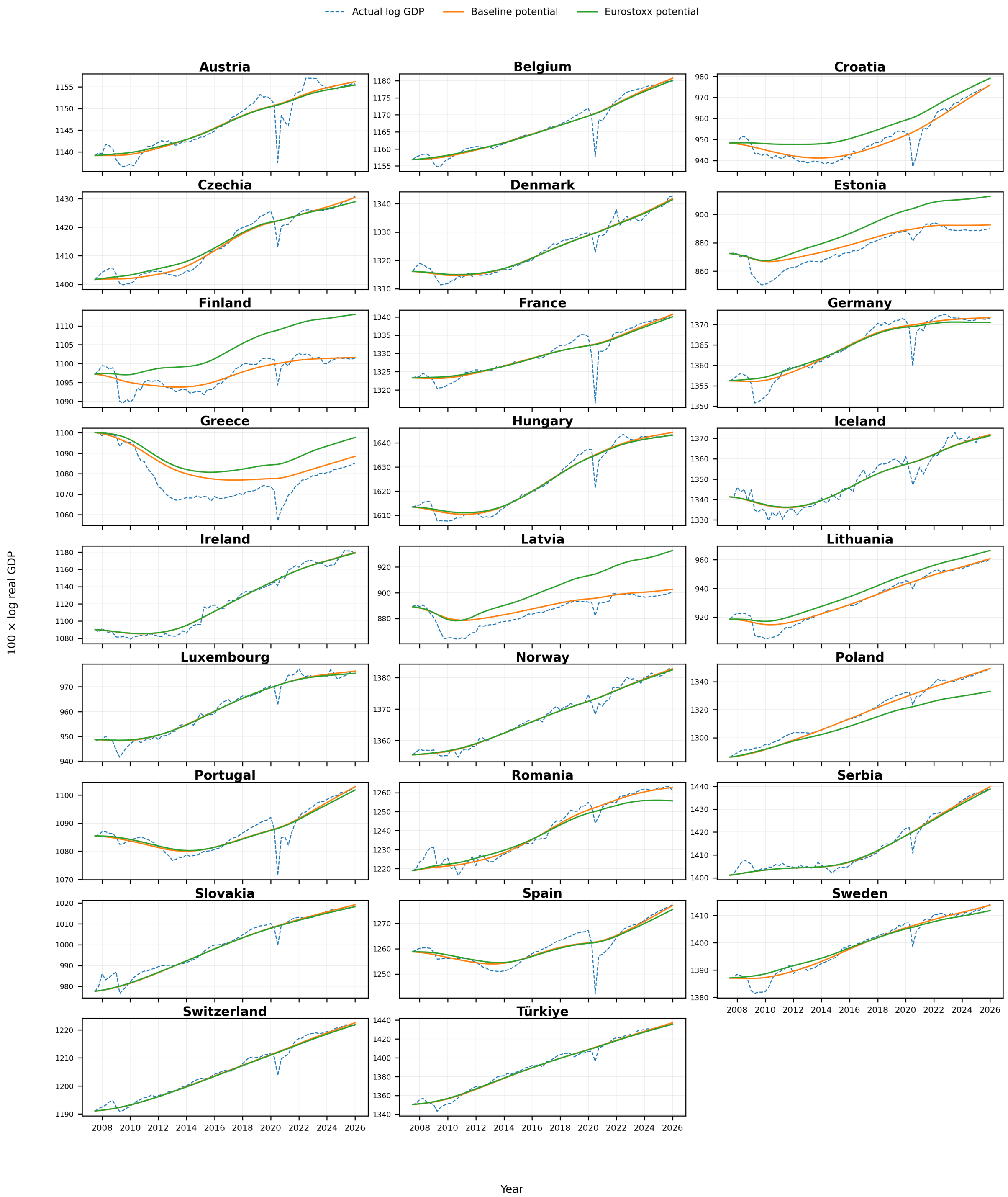

Figure 1: GDP and estimated potential output: baseline versus Eurostoxx50 model

The validation exercises indicate that the Eurostoxx50-augmented estimates are not uniformly better than the baseline estimates. In the Phillips-curve regressions, the Eurostoxx50 gap does not systematically improve the fit of the inflation equation. Similarly, in the real-time revision exercise, the Eurostoxx50-augmented model does not consistently produce smaller revisions than the baseline model. This means that the strong likelihood-based improvement documented earlier does not automatically translate into better performance in external validation tests.

The country-level figures help explain this result. For several countries, the Eurostoxx50-augmented model appears unable to identify a plausible potential-output path. This is especially visible for Croatia, Estonia, Finland, Greece, Latvia, Lithuania and Poland. In these cases, the model often assigns too much persistent variation to the cyclical component, which is also reflected in the very high estimated β values reported in Table 3. These countries also tend to perform poorly in the validation exercises, suggesting that the Eurostoxx50 factor improves the statistical fit of the state-space model without necessarily delivering a more credible decomposition of GDP into trend and cycle.

If these problematic cases are set aside, together with Ireland and Iceland where the Eurostoxx50 coefficient is not statistically significant, the Eurostoxx50-augmented potential-output estimates appear somewhat more informative overall. However, the evidence is clearly not as strong as the likelihood and AIC results alone would suggest. The main conclusion is therefore more cautious: the Eurostoxx50 return contains relevant common European financial-cycle information, but the Borio-style model that works well for the United States over the 1980–2012 period does not perform equally effectively for European countries over the 2007–2025 sample. In this setting, the common financial factor improves model fit, but it does not always lead to economically plausible or externally validated output-gap estimates.

6 Conclusion

This paper examined whether common European and global financial factors improve country-level output-gap estimates for 26 European economies. The empirical strategy used a Borio-style state-space model in which observed GDP is decomposed into latent potential output and a cyclical component. The cyclical equation was augmented with one common factor at a time, including European equity-market indicators, financial stress, oil prices, exchange rates, euro-area unemployment and short-term interest rates.

The analysis is not exhaustive for Europe. Several EU countries are not included because quarterly, seasonally and calendar adjusted real GDP series were not available from Eurostat from 1995Q1 onward. The results should therefore be interpreted as evidence for the covered country sample, rather than as a complete assessment of all EU economies.

The main empirical result is that the Eurostoxx50 return is by far the strongest common factor according to likelihood-based criteria. It improves the baseline model in almost all countries according to the AIC and in most countries according to the stricter BIC. This suggests that broad European equity-market movements contain substantial information about national cyclical positions. By contrast, the CISS financial stress indicator and Brent oil price changes are informative only for more limited groups of countries, probably reflecting differences in financial openness, energy exposure and external vulnerability.

At the same time, better statistical fit does not automatically imply a more credible output-gap estimate. The Eurostoxx50-augmented model often improves likelihood-based fit, but the external validation exercises give a more mixed picture. The Eurostoxx50 gap does not systematically improve simple Phillips-curve regressions, and it does not consistently reduce real-time endpoint revisions relative to the baseline model. Moreover, the estimated potential-output paths are implausible for several countries, where the model appears to assign too much persistent variation to the cyclical component.

This problem is closely related to the estimated persistence of the output gap. In several country specifications, the autoregressive parameter is very close to, or even above, unity. Such estimates are difficult to reconcile with the interpretation of the output gap as a temporary business-cycle component. They should therefore be interpreted as a diagnostic warning rather than as reliable evidence on cyclical conditions.

The main conclusion is deliberately cautious. Common European financial variables can improve output-gap estimation, but the improvement is not mechanical. The Eurostoxx50 return is a powerful indicator of common European cyclical and financial conditions, yet its inclusion is not sufficient by itself to guarantee credible output-gap estimates. The model is most useful when likelihood-based improvements, plausible potential-output paths and external validation evidence point in the same direction.

These findings imply that financial-market information should not be ignored in output-gap estimation, especially in highly integrated European economies. However, output-gap estimates should not be evaluated only by in-sample fit. Persistence diagnostics, real-time stability, external validation and visual inspection of potential-output paths are necessary before interpreting a factor-augmented gap as economically meaningful. Future work could extend the country coverage when longer GDP series become available, impose stricter stationarity restrictions on the cycle, compare all factors on a common post-2007 sample, and allow for country-group-specific financial channels.

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Appendix

AI disclosure

Generative AI tools were used as auxiliary support for language editing, text structuring, formatting and coding. This included improving the clarity of selected passages, refining section organisation, suggesting formatting changes for tables and figures, and supporting the writing and revision of code used in the empirical analysis.

The research question, choice of topic, selection of variables, empirical strategy, interpretation of the results and main argument were developed by the author. The focus on common European financial factors, including the Eurostoxx50, CISS and Brent oil prices, also originated from the author.

All empirical results, tables and figures were produced, checked and interpreted by the author, who takes full responsibility for the content, accuracy and conclusions of the manuscript.